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WORK OF THE HUNTLEY FIELD STATION, MONTANA, IN 1925 AND 1926

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INTRODUCTION

This report presents the results of investigational work with field crops and livestock at the Huntley Field Station in 1925 and 1926 and gives a summary of the more important experiments conducted at this station since it was established in 1910.

The Huntley Field Station is located on the Huntley reclamation project in the Yellowstone Valley of Montana. Soil and climatic conditions at this station are fairly typical of most of the Plains section of the southeastern part of the State.

The station is supported cooperatively by the United States Department of Agriculture and the Montana Agricultural Experiment Station. Facilities are provided for investigational work by various offices of the Department of Agriculture.

The investigational work includes experiments with both irrigated and dry-land field crops, and feeding, breeding, and management experiments with dairy cattle and hogs.

CLIMATIC CONDITIONS

The total rainfall in 1925 was 13.67 inches, and in 1926 it was 11.83 inches. The average annual precipitation during the 16-year period from 1911 to 1926, inclusive, during which climatic records have been kept at the Huntley station, was 14.30 inches, showing that in both 1925 and 1926 the rainfall was less than normal.

In both years the rainfall during the spring months was deficient, and with most crops it was necessary to irrigate to provide moisture

for seed germination. In many cases this resulted in poor and uneven stands and with sugar beets necessitated reseeding or the substitution of other crops on a small part of the original beet acreage. The winter of 1925–26 was very open and mild, with little precipitation. High winds during March and April following this dry winter resulted in soil blowing, which totally or partially destroyed stands of winter wheat on dry lands adjacent to the Huntley project.

The frost-free period in 1925 was 137 days whereas in 1926 it was 144 days, as compared with the 16-year average of 130 days. In 1926 a severe freeze on September 23 stopped all plant growth and resulted in lower yields and lower sugar content of beets than might have been expected under more normal conditions. This freeze also resulted in losses estimated at 10 to 25 per cent in yields of marketable potatoes.

In neither year was there any serious damage from severe storms or hail.

A summary of the climatological observations at the Huntley station for the 16 years from 1911 to 1926, inclusive, is given in Table 1.

TABLE 1.—*Summary of climatological observations at the Huntley Field Station during the 16-year period 1911–1926*

PRECIPITATION (INCHES)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Average, 1911 to 1926	0.64	0.42	0.80	1.13	2.25	2.50	1.46	0.82	1.47	1.12	0.84	0.85	14.30
For 1925	.65	1.10	.98	1.24	2.27	2.69	.53	.42	.54	1.24	.40	1.61	13.67
For 1926	.40	.40	.34	.33	1.55	1.28	2.22	.98	2.20	.10	1.67	.36	11.83

EVAPORATION (INCHES)

Average, 1911 to 1926	------	------	------	3.427	4.812	6.107	7.490	6.838	4.353	------	------	------	33.027
For 1925	------	------	------	3.680	5.401	5.314	7.646	7.032	4.367	------	------	------	33.440
For 1926	------	------	------	4.343	5.352	6.583	7.815	6.857	3.450	------	------	------	34.400

DAILY WIND VELOCITY (MILES PER HOUR)

Highest:													
1911 to 1926	22.2	14.1	27.8	17.8	17.5	10.2	27.5	7.9	10.5	29.4	25.0	26.6	------
For 1925	10.7	8.7	11.1	11.1	7.9	4.9	4.0	4.3	7.2	9.0	7.5	10.2	------
For 1926	9.6	8.2	9.8	8.2	15.2	5.8	5.3	7.2	8.6	6.0	6.4	10.6	------
Lowest:													
1911 to 1926	.3	.2	.1	.6	.2	.4	.3	.3	.1	.1	.1	.1	------
For 1925	.9	.2	.1	1.3	.7	.9	.4	.6	.2	.1	.3	.4	------
For 1926	1.3	1.3	1.8	1.6	1.8	1.6	1.4	.5	.1	.2	.1	.4	------
Mean:													
1911 to 1926	5.1	4.4	4.6	5.1	4.7	3.6	3.1	3.1	3.5	3.7	3.9	4.7	------
For 1925	4.7	3.1	4.1	4.5	3.3	1.9	1.7	1.9	3.2	3.7	3.3	3.8	------
For 1926	4.3	4.0	3.9	3.8	4.4	3.3	3.0	3.3	3.0	3.0	2.9	4.2	------

TEMPERATURE (° F.)

Absolute maximum:													
1911 to 1926	64	70	74	88	99	107	105	103	95	91	75	67	------
For 1925	58	55	74	80	89	97	104	96	94	68	63	63	------
For 1926	57	62	73	88	88	103	102	103	84	79	67	57	------
Absolute minimum:													
1911 to 1926	−39	−38	−37	4	22	32	38	33	16	−15	−28	−41	------
For 1925	−22	−10	−16	18	24	38	42	37	32	−15	13	−10	------
For 1926	−3	3	2	9	35	38	43	43	16	28	−19	−14	------
Mean:													
1911 to 1926	20	24	32	45	54	64	71	69	57	45	33	23	------
For 1925	23	30	35	49	56	63	70	68	58	35	36	31	------
For 1926	29	36	36	48	58	65	73	68	51	51	33	23	------

TABLE 1.—*Summary of climatological observations at the Huntley Field Station during the 16-year period 1911–1926*—Continued

KILLING FROSTS

Year	Last in spring		First in autumn		Frost-free period (days)	Year	Last in spring		First in autumn		Frost-free period (days)
	Date	Minimum temperature (° F)	Date	Minimum temperature (° F)			Date	Minimum temperature (° F)	Date	Minimum temperature (° F)	
1911	May 26	32	Sept. 18	28	114	1920	June 3	32	Sept. 24	32	112
1912	May 12	28	Sept. 15	31	125	1921	May 14	32	Sept. 9	32	117
1913	May 5	31	Sept. 19	29	136	1922	May 5	31	Sept. 28	29	145
1914	May 12	32	Oct. 6	31	146	1923	May 15	28	Oct. 11	30	148
1915	May 21	32	Sept. 19	32	120	1924	May 26	27	Sept. 14	32	110
1916	May 16	30	Sept. 13	31	119	1925	May 15	29	Sept. 30	32	137
1917	May 31	31	Sept. 28	32	119	1926	Apr. 26	31	Sept. 18	28	144
1918	May 21	32	Oct. 7	28	138						
1919	May 7	29	Sept. 27	32	142	Average	May 16	------	Sept. 24	------	130

CROPS AND LIVESTOCK ON THE HUNTLEY PROJECT

The total cropped area of the Huntley reclamation project during the two years covered by this report remained about the same as in previous years—approximately 20,000 acres. The crops of principal importance were alfalfa, sugar beets, and wheat, although the sugar-beet acreage was less in each of these years than in 1924. Other changes worthy of note were the increases in the production of beans and barley.

Alfalfa continued to occupy somewhat more than one-fourth of the total cultivated area of the project. The larger part of this crop was fed locally, principally to sheep, cattle, and work stock, although a small quantity was shipped out each year. The farm price per ton for hay sold was about $8 in 1925 and $9 in 1926.

The area cropped to beets in 1925 was about 4,400 acres, which was approximately 1,500 acres less than in the preceding year. In 1926, 4,700 acres were used for this crop. The price received for beets in 1925 was $6.50 per ton, while in 1926 the price advanced to $8.50 per ton. The average acre yield each year was slightly more than 11 tons. Yields in 1926 were no doubt affected to some extent by an unusually severe freeze in late September. Harvest conditions during both years were favorable. There was no serious injury from insect pests or plant diseases. In fact, none of the diseases or insects that seriously affect beet production have yet occurred to any considerable extent in this section.

Wheat was grown on about 3,800 acres. Crops of less importance were field beans, pasture crops, oats, barley, corn, and potatoes, which ranged in point of acreage in the order given.

The livestock census of the Huntley project, taken each year by the United States Bureau of Reclamation, indicates that except in the cases of sheep and poultry there have been no material increases in numbers in recent years. The fact that an increasing number of project farms are operated each year by tenant farmers who are interested usually in growing only cash crops probably accounts in large measure for this lack of interest in the keeping of livestock. The number of dairy cattle is reported in the last census as about

2,000, and this number has not varied greatly in the last five years. There are no large dairy herds, although some very good small herds are being developed by farmers who have been engaged in dairying for a number of years and who are now being assisted by the Huntley Field Station lending them purebred Holstein sires from the station herd.

The number of sheep kept on project farms increased during 1925 and 1926. In the latter year the number was reported as 10,836. While a large proportion of these are sheep and lambs brought in for winter feeding, there is an increasing number of small farm flocks of 20 to 100 ewes. The wool and lambs from these farm flocks are being marketed through a local cooperative organization.

In 1926 there were 46,279 fowls reported on project farms. This was an increase of nearly 100 per cent over any previous year. Poultry is kept in farm flocks of usually not more than 200 hens.

The number of hogs, which was given as 1,674 in 1926, was about the same as in previous years.

The number of each class of livestock on the Huntley project for the years 1914 to 1926, inclusive, is given in Table 2. This information was furnished by the United States Bureau of Reclamation.

TABLE 2.—*Number of livestock on farms on the Huntley Reclamation Project during the 13-year period 1914–1926*

Livestock	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Horses	2,008	1,961	1,961	2,145	2,120	2,297	2,041	1,865	1,875	1,547	2,158	2,027	2,089
Mules	53	53	58	80	51	46	34	58	61	33	60	45	47
Cattle:													
Beef	2,921	3,316	1,982	1,795	1,813	2,631	1,312	1,765	1,395	751	1,801	1,658	986
Dairy			1,753	1,949	1,920	2,040	1,804	1,542	1,951	1,534	2,250	1,968	2,006
Sheep	847	6,198	3,729	1,974	1,130	2,115	2,352	1,486	1,310	2,384	3,998	7,439	10,836
Hogs	4,612	4,866	2,791	2,363	2,391	3,097	1,885	1,365	1,622	1,190	1,600	1,572	1,674
Fowls	23,345	18,758	16,418	16,920	15,856	21,456	18,232	18,500	23,036	20,214	21,644	24,015	46,279
Bees, hives	249	288	282	296	424	458	180	442	210	193	187	435	454

EXPERIMENTS WITH IRRIGATED CROPS

ROTATION EXPERIMENTS[1]

In 1912 a comprehensive series of irrigated-crop rotation experiments was started on 70 quarter-acre plots in field K. This crop-rotation work has been continued without change since that date except for the addition in 1916 of 27 quarter-acre plots in field L–IV. Continuous results covering a period of 15 years in field K and 11 years in field L–IV are now available. The arrangement of the fields and the locations of the experiments are shown in Figures 1 and 2.

A standard adapted variety of each of the seven principal crops of local importance is included in these investigations. These crops, combined in various sequences, are grown in eleven 2-year, five 3-year, four 4-year, and six 6-year rotations. For purposes of comparison 14 additional plots are used for the continuous production of these crops on the same land each year.

[1] Report prepared by David A. Savage.

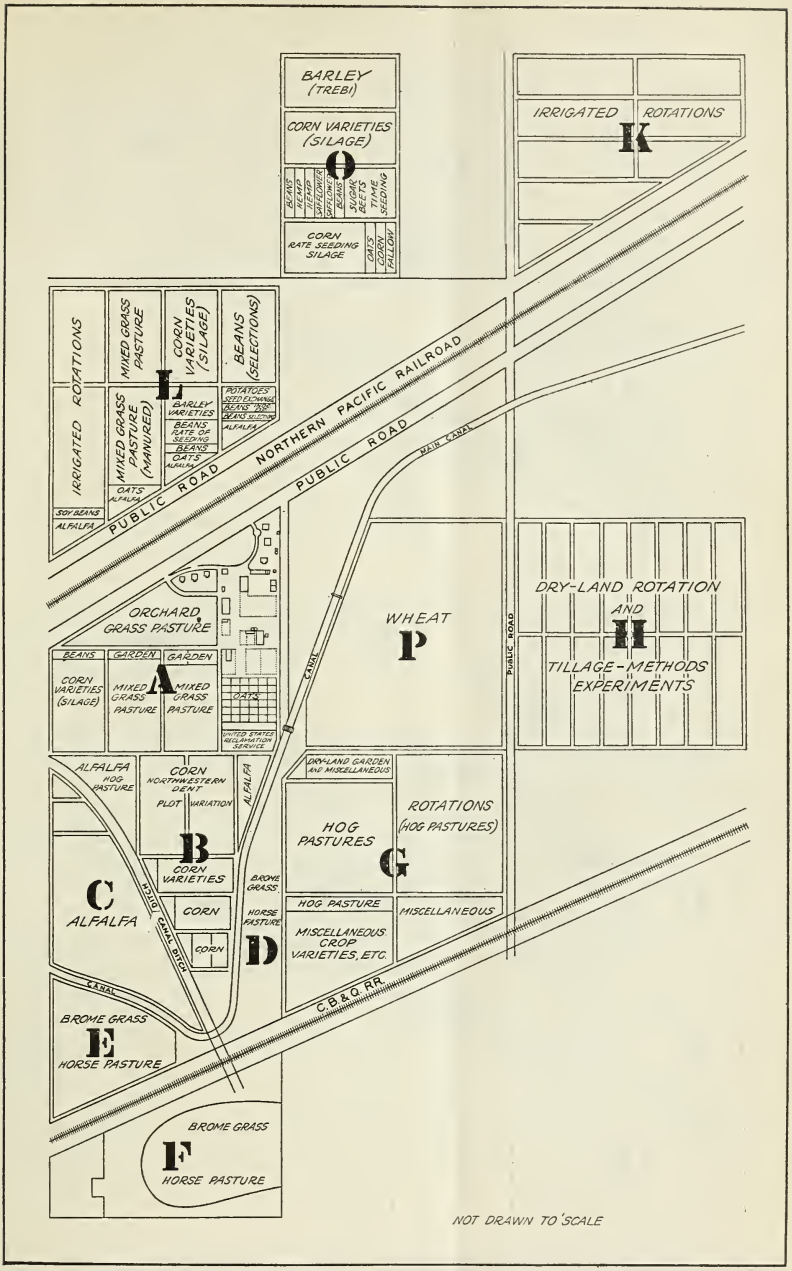

FIGURE 1.—Diagram showing arrangement of fields and locations of experiments at the Huntley Field Station in 1925

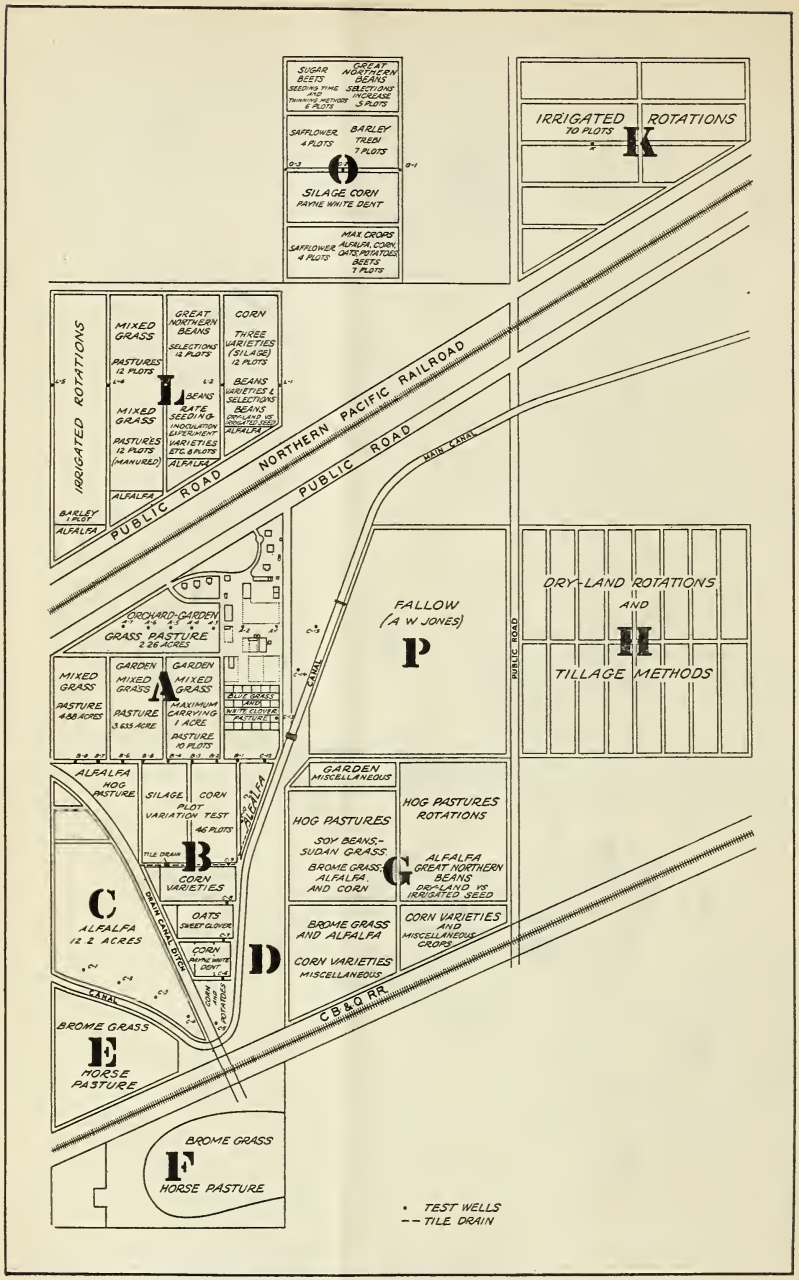

FIGURE 2.—Diagram showing arrangement of fields and locations of experiments at the Huntley Field Station in 1926

The aim of this work has been to determine the effect of crop sequence, the value of alfalfa, and the effect of manure in rotations, and to compare crop rotation with continuous cropping.

The results now available are considered of sufficient importance to indicate rather definitely the effect of manure, alfalfa, and crop sequence, and to point out the value of rotations as compared with that of continuous cropping. Further work is expected to substantiate the present more definite trend of results and to shed light on the more doubtful phases.

The value of rotations as compared with that of continuous cropping and the importance of crop sequence in the different rotations are indicated in the wide difference between the maximum and minimum yields of each crop. The highest yields are usually harvested in the longer rotations containing alfalfa or in those including manure. The lowest yields are generally obtained from the continuously cropped plots or short rotations which do not include alfalfa or manure. The difference between the highest and the lowest returns from each crop, with but few exceptions, has gradually increased since the experiments were begun. The poorer cropping systems have given lower yields, while the better cropping systems have maintained and often increased the yielding capacity of these soils.

ALFALFA

The average yields of alfalfa were 4.37 tons in 1925 and 4.50 tons per acre in 1926, both of which were above the average for the entire period of the experiment.

SUGAR BEETS

Table 3 shows the yields of sugar beets, potatoes, and oats in all rotations in 1925 and 1926, with averages for the 14-year period, 1913 to 1926, inclusive, arranged in descending order, together with a statement of crop sequences. The maximum, minimum, and average acre yields, respectively, of sugar beets were 18.12, 2.77, and 11.59 tons in 1925; 16.14, 3.33, and 9.77 tons in 1926; and 15.47, 8, and 11.68 tons for the 14-year period. The order of yields in the different rotations in 1925 was in fair accord with that for the entire period. On the other hand, considerable variation from the general order of average yields was apparent in 1926.

Considering the average results for the 14-year period, the eight highest yields of beets were obtained in rotations containing three years of alfalfa, or manure, or both. The six lowest yields were obtained on two continuously cropped plots and in four short rotations in which beets directly follow wheat or oats. The intermediate places in respect to average yields generally fell in 2-year, 3-year, and 4-year rotations in which beets were immediately preceded by potatoes, or two years of alfalfa, or both.

TABLE 3.—*Acre yields of sugar beets, potatoes, and oats, arranged in descending order of average yield, with statement of crop sequence, in 1925 and 1926 and averages for the 14-year period 1913–1926*

[The acre yields of sugar beets are stated in tons; those of potatoes and oats in bushels. Figures preceded by an asterisk (*) indicate rotations begun in 1916, representing therefore a 10-year period. In each case where manure is listed, it was applied after the preceding crop was harvested]

Crop sequence	Rotation No.	Acre yields		
		14-year average	1926	1925
SUGAR BEETS				
Alfalfa 3 years (third year hogged), corn (hogged), flax, beets	67	15.47	15.64	18.12
Potatoes, beets (manured)	21	15.24	15.88	16.03
Alfalfa 3 years, potatoes, oats (manured), beets	61	15.18	14.28	16.25
Oats (manured), potatoes, beets	35	*14.29	12.78	13.35
Oats, alfalfa 3 years, potatoes, beets	64	*13.21	10.23	13.77
Oats (manured), beets	23	13.09	16.14	16.05
Alfalfa 3 years, potatoes, oats, beets	60	12.71	16.09	16.03
Potatoes, oats (manured), beets	31	12.60	16.09	13.27
Potatoes, beets	20	12.27	9.63	9.75
Alfalfa 2 years, potatoes, beets	40	12.14	4.70	13.23
Oats, potatoes, beets	34	*11.57	5.04	9.44
Alfalfa 2 years, oats, beets	42	10.59	6.09	12.21
Oats, alfalfa 2 years, beets	46	*10.56	5.72	10.89
Corn, oats, beets	32	9.66	9.33	10.19
Oats, beets	22	9.57	5.57	4.39
Beets, continuous	2	8.97	6.61	7.89
Do	2-a	*8.77	4.98	2.77
Potatoes, oats, beets	30	8.05	7.45	7.96
Wheat, beets	18	8.00	3.33	8.61
Maximum		15.47	16.14	18.12
Minimum		8.00	3.33	2.77
Average		11.68	9.77	11.59
POTATOES				
Oats (manured), potatoes	25	316.1	307.3	340.7
Oats (manured), beets, alfalfa 3 years, potatoes	61	314.5	324.0	312.7
Beets, oats (manured), potatoes	35	*311.2	324.0	358.8
Beets, oats, alfalfa 3 years, potatoes	64	*305.4	394.0	369.6
Oats, beets, alfalfa 3 years, potatoes	60	293.1	324.7	310.7
Beets, alfalfa 2 years, potatoes	40	272.7	333.3	339.3
Beets, oats, potatoes	34	*264.6	216.7	295.8
Beets (manured), potatoes	21	239.7	274.6	269.3
Beets, potatoes	20	216.2	143.3	200.7
Potatoes, continuous	4-a	*204.8	92.0	166.2
Oats, potatoes	24	202.8	131.3	150.7
Oats, alfalfa 2 years, potatoes	44	199.8	309.3	236.7
Corn, potatoes	26	185.4	93.3	136.7
Oats, beets, potatoes	30	183.0	183.3	113.3
Oats (manured), beets, potatoes	31	176.1	237.3	92.7
Potatoes, continuous	4	148.2	88.7	96.0
Oats (rye), potatoes	27	97.1	174.0	74.7
Maximum		316.1	394.0	369.6
Minimum		97.1	88.7	74.7
Average		231.2	232.4	227.3
OATS				
Beets, alfalfa 3 years, potatoes, oats (manured)	61	97.6	95.8	117.5
Beets, alfalfa 3 years, potatoes, oats	60	95.4	80.8	126.3
Alfalfa 2 years, beets, oats	46	*94.4	103.4	101.3
Alfalfa 3 years (third year hogged), corn 2 years (hogged), oats	69	*94.1	95.3	101.3
Alfalfa 3 years, potatoes, beets, oats	64	*92.5	96.9	105.0
Beets, alfalfa 2 years, oats	42	89.0	75.6	102.5
Potatoes, oats (manured)	25	88.3	60.4	90.0
Potatoes, beets, oats (manured)	35	*87.5	62.5	76.3
Potatoes, beets, oats	34	*85.9	62.5	72.5
Alfalfa 2 years, potatoes, oats	44	83.5	66.3	96.3
Beets, oats	22	83.3	51.9	70.0
Beets, oats (manured)	23	79.7	64.8	81.3
Potatoes, oats	24	76.1	44.0	65.0
Beets, potatoes, oats (manured)	31	72.9	32.1	83.8
Beets, potatoes, oats	30	66.5	35.6	74.1
Corn, oats	16	66.3	43.8	55.0
Potatoes, oats	27	60.1	31.6	58.8
Beets, corn, oats	32	56.9	31.3	52.5
Oats, continuous	1-a	*56.6	34.0	42.5
Wheat, oats	28	48.6	17.9	46.3
Oats, continuous	1	38.0	19.2	36.3
Maximum		97.6	103.4	126.3
Minimum		38.0	17.9	36.3
Average		76.8	57.4	78.8

In rotations containing alfalfa but no manure, returns made where beets were preceded by potatoes following alfalfa were greater than in similar rotations in which oats were substituted for potatoes. Likewise, yields obtained where beets followed potatoes in short rotations not containing alfalfa were higher than where the crop was grown immediately after oats or wheat. The yields after potatoes in short rotations were even higher than those directly following two years of alfalfa. The yields of beets were decidedly smaller immediately following alfalfa than where an intermediate crop was grown.

The three highest average yields of beets were obtained in rotations 67, 21, and 61. These yields were at the rate of 15.47, 15.24, and 15.18 tons per acre, respectively. The sequence involved in rotation 67 comprises three years of alfalfa, the third year hogged, corn (hogged), and flax preceding beets. Rotation 21 is for two years in which potatoes alternate with beets and manure is applied to the beet ground after harvest. Rotation 61, covering a 6-year period, consists of three years of alfalfa followed by one year each of potatoes, oats (manured), and beets.

Beets grown continuously on the same plots, designated as rotations 2 and 2–a, produced average acre yields of 8.97 and 8.77 tons, respectively. Rotation 30 covers a 3-year period and is composed of potatoes, oats, and beets. Beets in this rotation yielded at the average rate of 8.05 tons per acre for the 14 years. The lowest average acre yield of 8 tons was made in a 2-year rotation in which beets alternated with wheat.

The effect of manure and alfalfa on the yields of beets in the irrigated rotations in 1925 and 1926 and on the average yields for the period from 1914 to 1926, inclusive, is shown in Table 4.

TABLE 4.—*Effect of manure and alfalfa on the yields of sugar beets, potatoes, and oats in the irrigated rotations in 1925 and 1926*

[Yields of sugar beets are stated in tons; yields of potatoes and oats in bushels. Five plots were used in growing sugar beets, for the manure checks of potatoes, and for the alfalfa land devoted to oats; for all other tests four plots were used. Included in the averages presented are the results of one rotation in each case covering a period of only nine years in field L–IV]

Year	Check for manure	Average acre yield			Increase in favor of—			
		Manured	Check for alfalfa	Alfalfa	Manure		Alfalfa	
					Tons	Per cent	Tons	Per cent
Sugar beets:								
1925	9.51	14.99	8.96	14.30	5.48	57.6	5.34	59.6
1926	8.76	15.03	8.75	10.28	6.27	71.6	1.53	17.5
13-year average	10.56	13.98	10.50	12.59	3.42	32.4	2.09	20.0
Potatoes:								
1925	214.2	274.8	190.1	314.1	60.6	28.3	124.0	65.2
1926	199.9	293.4	168.7	340.3	93.5	46.8	171.6	101.7
13-year average	229.1	270.1	211.4	265.2	41.0	17.9	53.8	25.4
Oats:								
1925	70.4	82.9	70.4	107.5	12.5	17.8	37.1	52.7
1926	48.5	55.0	48.5	79.9	6.5	13.4	31.4	64.7
13-year average	74.9	80.0	75.8	89.9	5.1	6.8	14.1	18.6

The yields of five different manured rotations and five alfalfa rotations are compared in turn with those from an equal number of rotations that are identical in all respects except that no manure or alfalfa, as the case may be, was used. According to the results, manure and alfalfa in rotations are pronounced stimulants to the growth of beets. The difference in this respect is considerably in favor of manure, which may be due to the fact that crop sequences are more advantageous to beets in manured rotations. In rotations containing alfalfa, beets are grown one to two years after the alfalfa ground is plowed up. In manured rotations the manure is usually applied immediately preceding the beets. Because of these facts it is difficult to make a direct comparison of the relative effect of manure and alfalfa in all cases, although the beneficial influence of each is clearly apparent in the results.

Manure is shown to have resulted in an increase of acre yields of beets averaging 5.48 tons in 1925, 6.27 tons in 1926, and 3.42 tons for the 13-year period. The increases due to alfalfa averaged 5.34 tons in 1925, 1.53 tons in 1926, and 2.09 tons for the entire period of the experiment.

The results of a single comparison of manure and alfalfa rotations in which manure holds the same place with reference to beets as does alfalfa show the advantage in favor of manure to be the same as that apparent in the general average of all rotations. The data for all of the years show manure and alfalfa to have caused a gradual increase in yields, whereas the yields of the check rotations decreased.

A direct application of manure to beets in two rotations without alfalfa caused an average acre increase of 4.41 tons as compared with an average increase of 3.06 tons from an equal number of rotations in which manure was applied one year in advance of beets.

Manure in one of the two 6-year rotations containing alfalfa resulted in an average acre increase of 2.34 tons of beets. Although the increase due to manure was lowered somewhat by the equalizing effect of alfalfa, it was sufficiently large to emphasize the value of including manure in beet rotations containing alfalfa.

POTATOES

The average acre yield of potatoes, as shown in Table 3, was 227.3 bushels in 1925, 232.4 bushels in 1926, and 231.2 bushels for the 14-year period 1913 to 1926, inclusive. The maximum acre yields in 1925 and 1926 were 369.6 and 394 bushels, respectively, as compared with the highest average yield of 316.1 bushels for the entire period. The minimum acre yields in 1925, 1926, and for the 14-year period were 74.7, 88.7, and 97.1 bushels, respectively. The maximum yields for 1925 and 1926 were obtained in a 6-year rotation in which potatoes are directly preceded by three years of alfalfa following oats and beets. The highest average for the 14-year period was in a 2-year rotation wherein potatoes were grown on manured oats stubble. The minimum yield in 1926 resulted from a continuously cropped plot, whereas the lowest yield in 1925 and for the 14-year average was in a 2-year rotation of oats and potatoes with winter rye seeded in the fall and spring plowed as green manure in preparation for potatoes.

Considering the average results more in detail, the six highest yields of potatoes were harvested where the crop was directly preceded by manure or alfalfa. In four short rotations not receiving manure or containing alfalfa but yet comparable in regard to crop sequence, the average acre yield of potatoes following oats during the 14-year period was 233.7 bushels, while that following beets was 199.6 bushels. Potatoes following corn in a 2-year rotation produced average yields at the rate of 185.4 bushels.

A summary of results showing the effect of manure and alfalfa on the yields of potatoes for the 13-year period is made in Table 4.

The influence of manure and alfalfa when considered in relation to potato yields is determined in a study of five pairs and four pairs of rotations, respectively. The rotations in each pair are identical in every respect except that one of them contains manure or alfalfa, as the case may be, while the other does not. Substantial increases resulted from the growing of potatoes in both alfalfa and manured rotations, with the margin of difference in favor of alfalfa, in contrast with that obtained from beets. Potatoes follow alfalfa directly in every case, while they are immediately preceded by manure in but three rotations. In a 3-year rotation they are one year removed, and in a 6-year rotation they are four years removed from the direct influence of manure.

The average acre increase resulting from manure was 41 bushels, or 17.9 per cent, whereas that due to alfalfa was 53.8 bushels, or 25.4 per cent.

Included in the above-mentioned averages are the results covering nine years embodying three rotations from which a more direct comparison of the relative effect of manure and alfalfa is made possible. A 3-year rotation consisting of beets, oats, and potatoes is compared in turn with the same crop sequence containing manure in one rotation and three years of alfalfa in another. Potatoes directly follow manure and alfalfa in each case. The average acre increase caused by manure was 52.5 bushels, while the increase due to alfalfa was 40.9 bushels, emphasizing the value of each and particularly that of manure.

The average acre increase obtained from two rotations in which manure was applied a year or more in advance of potatoes was 9.3 bushels, while that resulting from three rotations where direct applications were made was 64.7 bushels.

The effect of three years of alfalfa in two rotations and of two years of alfalfa in a like number of rotations was to increase the acre yields of potatoes 76 and 34.7 bushels, respectively, indicating the importance of leaving alfalfa on the ground at least three years.

OATS

The average acre yields in 1925, 1926, and for the 14-year period were 78.8, 57.4, and 76.8 bushels, respectively. Adverse weather conditions, in the form of drought in the spring and a hailstorm the latter part of the growing season, were responsible for the poor returns in 1926, whereas favorable growing conditions in 1925 gave an average yield above that for the entire period of the experiment. The maximum yield for 1925 was obtained in rotation 60; for 1926, in rotation

46; and for the 14-year average, in rotation 61, containing both alfalfa and manure. The minimum acre yield in 1925 was 36.3 bushels; in 1926, 17.9 bushels; and for the 14-year average, 38 bushels. The minimum yield in 1925 and for the 14-year period occurred on a continuously cropped plot, whereas the lowest yield in 1926 was obtained in a 2-year rotation of wheat and oats.

The yields of oats, as arranged in descending order of average yield and presented in Table 3, show the eight highest yields to have been obtained in rotations containing alfalfa or manure or both. The three lowest yields were obtained on two continuously cropped plots and in a 2-year rotation of wheat and oats. Oats produced on the average 7.5 bushels per acre more in rotations directly following beets than in sequences after potatoes. The yield following corn (hogged) was higher than the yields following beets or potatoes, while those preceded by untreated corn were decidedly lower. In every instance oats directly following an intertilled crop produced higher yields than when grown after small grains.

The beneficial effect of manure and alfalfa on the yields of oats in the irrigated rotations for the years 1925 and 1926 and for the 13-year period 1914 to 1926, inclusive, is shown in Table 4.

Four pairs of rotations are represented in the summary for both alfalfa and manure. One rotation in each pair receives neither alfalfa nor manure and is used as a check on the effect of manure and alfalfa in a similar rotation.

Manure is shown to have caused an average acre increase of 5.1 bushels, or 6.8 per cent, while alfalfa caused an increase of 14.1 bushels, or 18.6 per cent, showing the advantage to be decidedly in favor of alfalfa. Crop sequence is accountable only in part for this difference. In half of the manured rotations oats are one crop removed from the direct effect of the treatment, and in the other half they are two crops removed therefrom. In two of the alfalfa rotations one crop intervenes between oats and alfalfa, in one rotation two crops intervene, and in still another rotation oats are grown directly following alfalfa.

Included in the averages reported are results covering eight years of a single manured rotation and nine years of an alfalfa rotation, compared with a check in which the crop sequences are uniform. There are two crops between the manure and alfalfa and the oats. The results of this direct comparison agree rather closely with those obtained from the summary of all treatments. Manure was responsible for an acre increase of 4.1 bushels, whereas alfalfa gave an increase of 9.6 bushels.

Considering the results of all rotations, the yields of oats were higher in rotations containing three years of alfalfa than in rotations containing two years of alfalfa. Returns obtained directly following alfalfa were lower than those where an intermediate crop was grown.

CORN

The acre yields of corn in 1925 ranged from a maximum of 65 bushels to a minimum of 23.2 bushels, with an average of 45.8 bushels, while those in 1926 varied from 63 to 16 bushels, with an average of 38.4 bushels. The highest yields for the entire period of the experiment were obtained in 6-year rotations containing alfalfa and in which alfalfa preceding corn was pastured with hogs. The minimum yields

occurred on the continuously cropped plots and in a 2-year rotation of oats and corn. The average acre yield of corn for the entire period of the experiment was 46.5 bushels.

WHEAT

The average acre yields of wheat, grown in but two 2-year rotations and on three continuously cropped plots, was 25.5 bushels in 1925, 19.1 bushels in 1926, and 25.7 bushels for the 13-year period 1914 to 1926, inclusive.

EXPERIMENTS WITH CORN

Corn is grown with fair success in a limited way on the Huntley project and in other low irrigated valleys in the eastern part of the State. The types of corn that can be grown successfully here are of such character that the crop is used to the best advantage for silage, bundle feeding, or for pasturing with hogs and sheep and will therefore be limited to an area that can be utilized profitably for these purposes on the farm where it is produced.

Experiments with corn at the Huntley station have been conducted for a number of years and have included (1) tests of a large number of varieties for silage and grain production, (2) the use of corn in crop-rotation experiments, and (3) the use of corn for "hogging off." The results of these experiments indicate that only the earlier and smaller varieties of corn are certain to mature in the comparatively short growing season in this section. These varieties are included in the early flints, the semident, and the early dent types. Several of these early adapted varieties that give fairly high yields of both grain and fodder have been grown and developed locally for a number of years.

TESTS OF PROMISING VARIETIES

A large number of varieties of corn have been grown in tests of both grain and silage production at the Huntley station for several years. In the earlier tests were included many varieties in all classes from the early flints to the later dents. Many of these were discarded as being of little promise, and the more recent tests have been limited to varieties that were grown previously in some part of the State where climatic conditions were similar to those of the Huntley project, or to varieties that appeared from earlier experiments to give promise of value. The varieties were grown each year on duplicate or triplicate twentieth-acre plots. The results obtained during the years 1922 to 1926, inclusive, with 10 varieties are given in Table 5.

Not all of these varieties were grown each year, so that the results are not in all cases entirely comparable. The Silver King variety was grown only during the last four years. Northwestern Dent (Oscar Will) has been grown since 1924, and the varieties Minnesota 13 (Haney) and Wisconsin 25 were not included in the test until 1926.

TABLE 5.—*Yields of corn in variety test, 1922–1926*

Variety	1922			1923			1924		
	Date mature	Acre yields		Date mature	Acre yields		Date mature	Acre yields	
		Grain	Fodder		Grain	Fodder		Grain	Fodder
		Bush.	*Tons.*		*Bush.*	*Tons*		*Bush.*	*Tons*
Rainbow [1]	Sept. 20	81.9	7.60	Oct. 10	85.8	7.50			
Silver King [1]				Sept. 30	81.0	5.59	[2]		
Payne White [1]	Sept. 10	78.1	6.17	Sept. 15	65.2	4.27	Oct. 1	48.4	6.53
Calico [1]	Sept. 25	70.5	6.90	Sept. 22	76.5	5.85	Oct. 5	42.2	7.15
Northwestern Dent (Oscar Will)							Sept. 25	51.7	7.21
Northwestern Dent (Huntley)	Sept. 10	61.2	5.27	Sept. 15	55.8	3.53	Sept. 25	54.5	6.51
Minnesota 13 (Owen)	Sept. 20	64.9	5.92	Sept. 22	57.8	4.53	[2]		
Minnesota 23 (Coleman)	Sept. 10	61.9	4.18	Sept. 5	38.8	2.60	Sept. 20	39.9	4.23

Variety	1925			1926			Average		
	Date mature	Acre yields		Date mature	Acre yields		Number of plots	Acre yields	
		Grain	Fodder		Grain	Fodder		Grain	Fodder
		Bush.	*Tons*		*Bush.*	*Tons*		*Bush.*	*Tons*
Rainbow [1]	Sept. 25	50.7	5.97	Oct. 1	47.6	6.27	11	68.3	6.89
Silver King [1]	Sept. 30	66.6	6.27	do	41.8	4.76	8	65.9	5.64
Payne White [1]	Sept. 20	65.6	5.87	Sept. 15	57.8	4.31	13	64.5	5.43
Calico [1]	Sept. 25	66.6	6.43	Sept. 25	54.6	4.79	13	64.2	6.26
Northwestern Dent (Oscar Will)	Sept. 15	58.9	5.80	Sept. 12	62.4	4.69	7	57.9	5.89
Northwestern Dent (Huntley)	do	53.1	4.37	do	57.1	4.17	13	56.4	4.67
Minnesota 13 (Owen)	Sept. 25	61.8	6.33	Sept. 25	29.9	3.19	11	55.8	5.16
Minnesota 13 (Haney)				Sept. 18	54.3	4.38	2	54.3	4.38
Wisconsin 25				do	52.2	4.11	2	52.2	4.11
Minnesota 23 (Coleman)	Sept. 10	42.4	3.43	Sept. 10	48.2	3.35	13	46.6	3.52

[1] Varieties producing high average yields, but not recommended because of late maturity.
[2] Roasting-ear stage at frost.

The larger and later varieties, which include Rainbow and Silver King, produced the highest average yields, but were fully matured only in the most favorable seasons and are not to be recommended for this section. The Calico variety, while slightly earlier, is not entirely dependable and is not generally to be recommended for grain, but because of its high fodder yield it might be grown to advantage to some extent for silage.

The Payne White variety (a selection of Rustler) matured fully in all but one year and because of its high yield of both grain and fodder is considered to be a very desirable variety for local conditions. Northwestern Dent, which yields slightly less than Payne White, is somewhat earlier and is one of the standard and dependable varieties. Minnesota 23 is the earliest of the dent varieties, but gives relatively low yields and is not to be recommended for sections where the larger varieties will reach maturity. Minnesota 13 (Haney strain) and Wisconsin 25, both yellow dents, were grown in the test for the first time in 1926. These varieties are both earlier than the standard Minnesota 13 and promise to be of value under local conditions.

TESTS OF VARIETIES FOR SILAGE

Varieties of corn that are found to be satisfactory for grain production are usually to be recommended also for silage, and for this purpose it is advisable to grow corn that is fairly certain to mature. Immature or soft corn can probably be used to better advantage for silage than for other methods of feeding, although there appears to be no question that silage to be of the best quality and feeding value should be made from corn that is fairly well matured.

A number of varieties of corn were grown in tests of comparative yield at the Huntley station from 1922 to 1926, inclusive. Included in these experiments were varieties of the early dent and semident types as well as those classed as late dents in the corn-growing sections of Montana. One of these tests included the Calico, Mitchell, Payne White, and Northwestern Dent varieties. Mitchell is a comparatively large, white corn, seed of which was obtained each year from Mitchell, Nebr. Seed of the Calico variety for the first year was obtained from the same place, but this variety was found to be sufficiently early maturing to produce seed in favorable seasons, and home-grown seed was used after the first year. The two varieties last named are both early maturing and are commonly grown locally. The tests each year were conducted on ¼-acre plots. The results of the test with these four varieties are given in Table 6.

TABLE 6.—*Average acre yields of silage corn in the variety test, 1922–1926*

Variety	1922		1923		1924		1925		1926		Entire period	
	Number of plots	Acre yield	Number of plots	Acre yield	Number of plots	Acre yield	Number of plots	Acre yield	Number of plots	Acre yield	Number of plots	Acre yield
		Tons		*Tons*		*Tons*		*Tons*		*Tons*		*Tons*
Calico	6	11.82	6	15.33	6	14.90	1	13.58	4	13.47	23	13.90
Mitchell	6	11.34	6	14.26	6	14.60	1	14.50	------	------	19	13.46
Payne White	6	11.48	6	13.37	6	13.27	1	10.64	4	12.59	23	12.59
Northwestern Dent	6	9.24	6	11.47	6	11.98	1	9.28	4	11.01	23	10.85

The highest average acre yield of 13.9 tons for the 5-year period was produced by the Calico variety. This variety, however, has a tendency toward late maturity and, unless improved in this respect by further years of selection, is not to be generally recommended. Mitchell was grown only during the first four years of this period, and although the yield was fairly high, it was discarded as being too late in maturing. Payne White, which produced an average acre yield of 12.59 tons, was found to mature sufficiently early each season and appears to be especially promising as a silage corn for this section. Northwestern Dent, which gave the lowest yield (10.85 tons), was fully matured each year.

TESTS OF LATE DENT VARIETIES

In another test covering the three years from 1923 to 1925, inclusive, three late Dent varieties—Silver King, Wisconsin 12 (Golden Glow), and Minnesota 13—were grown in comparison with Payne White and Northwestern Dent. The large varieties yielded from 1½

to 3 tons per acre more than the early varieties but did not reach a stage near maturity and are considered to be rather late for this section.

EXPERIMENTS WITH FIELD BEANS

Field beans have become a crop of some importance locally on irrigated land in recent years and under favorable conditions yield very satisfactory returns. On the Huntley project in 1926 slightly more than 1,000 acres were used for this crop, while in the upper section of the Yellowstone Valley there was a much larger acreage. The acre yields of this crop range from 1,200 to 1,500 pounds. Under especially favorable conditions yields up to 2,500 pounds have been obtained.

The Great Northern variety is grown almost exclusively and appears to be superior in yield and disease resistance for this section. It was not grown to any large extent until recent years and does not appear to be as definitely fixed in type and uniformity as the older varieties. With a view to improving the crop in these respects, as well as in yield and disease resistance, some work was begun at the Huntley station in 1923 and has been carried on since. In 1923 a large number of individual plant selections were made in a commercial field of this crop. These selections are being grown in comparative tests for yield, quality, and disease resistance; and such of them as appear to be superior in these qualities are being increased to be used as standard seed for distribution among growers.

The production of seed beans of some of the important canning and garden varieties has also received some attention locally and has possibilities of further development.

Rate of seeding.—Tests in seeding rates per acre were conducted in 1925 and 1926 with Great Northern beans. In 1925 six seeding rates were used. These varied from 15 to 40 pounds per acre in 5-pound spreads. In 1926 four rates of seeding, from 16 to 44 pounds, were used. The average results of the two years show that maximum yields were obtained where the acre rate of seeding was about 35 pounds. A higher rate than this failed to make any increase in yields, whereas lower rates resulted in correspondingly lower yields.

Seed inoculation.—Tests in seed inoculation of the Great Northern beans were made in 1925 and 1926. In these tests the seed was treated with a commercial preparation known as "nitragin" and comparative yields were obtained from this seed and from seed not treated. Duplicate plots were grown each year in each part of this test. The average acre yield for the two years from the treated seed was at the rate of 1,659 pounds, while the untreated seed produced at the rate of 1,680 pounds, indicating that there was no advantage in seed treatment under these conditions.

Comparison of striped and clear-pod beans.—In commercial fields of Great Northern beans some of the plants are observed to have distinctly striped pods, but others have clear-wax pods. Selections were made in 1924 of plants of each of these characters, and in 1925 and 1926 these were grown in comparative yield tests. The test included each year two twentieth-acre plots of each selection. The yields each year were slightly in favor of the clear-pod beans. The average acre yield of this selection in the two years was at the rate of 1,877 pounds, which was 159 pounds higher than the yields of the striped-pod selection.

Dry-land and irrigated bean seed.—To determine the value of seed beans produced on dry land as compared with seed produced on irrigated land a test was begun in 1926. Both lots of seed were produced from seed of the same source grown under irrigation in 1924. The experiment was conducted on duplicate plots. The average results for the one year were very slightly in favor of the dry-land seed, the acre yield being at the rate of 1,632 pounds as compared to 1,564 pounds from the irrigated seed.

Bean varieties in 1926.—Four varieties of beans were grown in a comparative-yield test in 1926. The varieties were Great Northern, Mexican Red, Red Kidney, and Burpee's Green Pod Stringless. The latter variety is commonly used as a garden and canning bean and has been grown locally to some extent for seed purposes in recent years. The Mexican Red variety returned the highest yield, which was at the rate of 1,820 pounds per acre. The market demand for this variety, however, is rather limited, and it is not extensively grown. The next highest acre yield (1,578 pounds) was obtained with the Great Northern variety. Red Kidney and Burpee's Green Pod Stringless yielded at the rates of 549 and 1,063 pounds, respectively.

EXPERIMENTS WITH SUGAR BEETS

Experiments with sugar beets other than those in the irrigated rotations, which are discussed elsewhere in this report, included tests of time of seeding and methods of thinning. The results of these experiments emphasize the importance of early seeding and of leaving the large beet plants when thinning.

TIME OF SEEDING

In the seeding-date experiment, which was conducted in 1924 and 1926, early and late seeding were compared. The average date of the early seeding was April 21, which in average seasons is about as early as the ground can be prepared. The date of late seeding was May 22, a difference of about one month. The seeding rate in each test was 20 pounds per acre. Other cultural operations, as well as the date of harvesting, were uniform in all cases. The experiment was conducted each year in duplicate on ¼-acre plots. The yields obtained in this experiment are given in Table 7.

The results indicate that the yields each year were in favor of the plots that were seeded early. The average difference in favor of early seeding was 2.79 tons per acre.

TABLE 7.—*Acre yields of sugar beets in the time-of-seeding experiment in 1924 and 1926*

Method	1924		1926		Average acre yield, 2 years
	Date of seeding	Acre yield	Date of seeding	Acre yield	
		Tons		*Tons*	*Tons*
Early	Apr. 22	19.55	Apr. 20	16.01	17.78
Late	May 20	15.12	May 24	14.86	14.99

METHOD OF THINNING

In ordinary practice sugar beets are seeded thickly in the row, and the plants are thinned by hand to a distance of approximately 12 inches apart for best results. This work is done by contract labor, and frequently little attention is paid to the selection of plants that are left. Recent investigations appear to indicate that by selecting the largest and most vigorous plants it is possible to increase the yield. The results of an experiment at the Huntley station in 1926 in which the two methods of thinning were compared appear to substantiate this view. Beets thinned by the ordinary method returned a yield of 16.01 tons per acre, whereas those from comparative plots in which the large plants were left at thinning yielded at the rate of 17.32 tons, a difference of 1.31 tons.

EXPERIMENTS WITH POTATOES

Experiments begun in 1924 to determine the comparative value of seed potatoes grown on dry land with potatoes grown under irrigation in maintaining yield and quality were continued in 1925. Two varieties, Green Mountain and Bliss Triumph, were used. The seed was grown each year from seed originally from the same source. The experiment was conducted in duplicate each year on plots about one-twentieth acre in size. The results of these tests are presented in Table 8.

The yields of the Triumph variety were in favor of the irrigated seed in 1924, and of the dry-land seed in 1925, although the differences were but slight in either year. Of the Green Mountain variety, the highest yields were obtained in both years from the seed grown under irrigation.

TABLE 8.—*Yields of potatoes in irrigated-land and dry-land seed exchange experiments in 1924 and 1925*

Variety	Source of seed	Acre yields (bushels)		
		1924	1925	Average
Bliss Triumph	Irrigated	356.9	577.1	467.0
	Dry land	374.6	508.2	441.4
Green Mountain	Irrigated	356.9	470.8	413.8
	Dry land	331.7	398.5	365.1

EXPERIMENTS WITH SAFFLOWER

In cooperation with the Office of Drug, Poisonous, and Oil Plants of the Bureau of Plant Industry some test plantings of safflower were made at the Huntley station in 1925 and 1926. The seed of this plant, which has never been grown extensively in this country, bears an oil that appears to have promise of value in the manufacture of paint.

Yields of this crop in the tests made in the two seasons were very satisfactory. In 1925 two ¼-acre plots were seeded in 12-inch drills. The average acre yield of seed from these plots was at the rate of 2,806 pounds. In 1926 eight ¼-acre plots of this crop gave a yield at the rate of 2,130 pounds per acre. The seed from these plantings is being used in crushing tests and for distribution among farmers for additional trials.

ORNAMENTAL TREES AND SHRUBS [2]

A number of trees and shrubs were set out around the station grounds in 1914, and in 1917 extensive plantings, including a large variety of trees and ornamental shrubbery, were made on a 4-acre tract of land known as Project Park, adjacent to the experiment farm. In addition to beautifying the grounds, the plantings serve as screens, hedges, and windbreaks, and provide shade during the summer.

These plantings were made from nursery stock obtained from dealers and from the Northern Great Plains Field Station, at Mandan, N. Dak., and have been given ordinary care in the way of cultivation and irrigation since they were set out. As soon as the single-

FIGURE 3.—View of trees and shrubs planted in 1917, Project Park, Huntley Field Station, 1926

stem types of trees, such as box elder, elm, or ash, have become large enough to shade the ground between the rows the lower branches to a height of 6 or 7 feet have been pruned off to permit free passage under them. Bushy types of trees, such as the willows used in windbreaks and screens, for the most part have been left unpruned.

All of the plantings furnish a striking demonstration as to what may be accomplished in a few years toward beautifying the farmstead with trees and shrubbery and the use of such material in windbreaks, hedges, and screens for outbuildings, corrals, and the like. Further utility features from such an enterprise would be the fuel, posts, and poles that suitable plantings would ultimately supply.

The following is a list of the trees and shrubs that have been grown under irrigation at the Huntley station, with a brief summary of the results obtained.

[2] Report furnished by A. E. Seamans.

TREES

Ash, green.—Planted in 1913, 1917, and 1918 from stock obtained locally and from the Northern Great Plains Field Station, Mandan, N. Dak., the green ash has proved itself entirely hardy for Huntley conditions. Its growth is comparatively slow, but it has strong crotches and limbs which are not easily broken by wind or ice. No serious disease has yet been found in these green-ash plantings. The chief insect pests noted have been Cecropia larvae, leaf miners, and flea beetles. In height the green ash averaged 18 to 25 feet in 1926, depending upon the year planted, and had an annual growth of 8 to 18 inches.

Basswood.—A few trees of basswood were planted on the station grounds in 1913. The percentage of survival has been very good. These trees now have an average height of 20 feet and have made an average yearly growth of about 12 inches. No serious insect pests or diseases have been found on these specimens.

Box elder.—Grown singly and in groves, the box elder has proved itself well adapted to conditions at Huntley. Plantings were made in 1913, 1917, and 1918, and the height of these trees in 1926 ranged from 25 to 35 feet, while the average yearly growth was 3 feet. Insect pests associated with this species are principally the black-and-red "box elder bug," aphids, and Cecropia.

Cottonwood, western.—One specimen of western cottonwood was planted on the station grounds in 1913. This tree in 1926 was about 50 feet high, and the yearly growth was about 3 feet. Injury from borers has been slight, and the tree has apparently been free from disease.

Elm, American.—Individual elms were planted at the station in 1913, and in 1917 and 1918 the same species was planted in groves in Project Park. The older trees now average 35 feet in height, while the elms in the park are about 20 feet high. The yearly growth has ranged from 3 to 6 feet. This species has proved to be generally winter hardy. Under irrigation, the elm frequently makes a top-heavy growth, and the splitting off of large limbs is not uncommon during windstorms. Aphids appear to be the chief insects attacking the elm in this vicinity.

Elm, Chinese.—Groves of Chinese elm were planted in Project Park in 1918 with nursery stock received from the United States Plant Introduction Garden at Chico, Calif. During the severe winter of 1919–20 many of the young trees were killed to the ground. Since that time, however, winter injury has been confined to occasional tip killing. In 1926 the average height of these trees was 25 feet and the yearly growth ranged from 4 to 8 feet. This species, like the American elm, sometimes makes a top-heavy growth that is rather easily broken down in a high wind. So far it has been free from insects and disease, with the exception of a type of bark canker that gains entrance through accidental injuries and pruning wounds.

Maple, soft.—A few soft-maple trees were planted at the station in 1913. These trees were 20 feet high in 1926 and have proved to be quite hardy. They have been free from disease and insect pests.

Pine, western yellow (bull).—Specimens of bull pine were planted on the station grounds in 1913 and in Project Park in 1917. A large percentage of these trees died the first season, but those that survived have made satisfactory growth. The older trees were about 15 feet high in 1926, while the younger ones averaged 5 feet in height. The yearly growth has been about 1 foot. The principal drawback so far encountered with this species is the difficulty in getting the trees established.

Plum, native wild.—A number of wild-plum trees were included in the group plantings in Project Park in 1917. Where not too crowded by the faster-growing species they have done well. They are apparently quite winter hardy and thus far have been comparatively free from disease and insect pests. The greatest objection to the wild plum has been the thicket-forming habit due to the profuse growth of shoots from the roots of the parent trees. Fruit has been produced on these trees in seasons when the blossoms have escaped injury from late frost.

Poplar.—Plantings of Carolina, Norway, and silver-leaf poplar were made in 1913, 1917, and 1918. The poplars have all grown rapidly, the average annual tip growth being 3 to 4 feet. All of the varieties have been susceptible to various diseases, such as canker and leaf ailments, and to the attacks of the cottonwood borer. Practically all of the older trees have died and have been removed, and many of the younger ones are showing the effects of the various destructive agents.

Russian olive.—Russian olive trees grown from seed in 1911 have been planted on the station grounds as individual trees and in a hedge. This species has proved to be quite hardy under local conditions and has been only slightly affected by disease. The average height of the Russian olive trees in 1926 was 18 feet.

Spruce, Black Hills.—Specimen trees of Black Hills spruce were planted about the station grounds in 1913 and in 1926 had attained an average height of 11 feet. These trees are rather difficult to start, but when once established are quite hardy and free from disease and insect pests.

Walnut, black.—A few trees of black walnut, planted in a favorable location at the station in 1911, have done very well. In 1926 the tallest of these was about 25 feet in height. The species has seemed to be winter hardy and free from injurious insect pests and disease. A small crop of nuts has been gathered from these trees during each of the last five years.

Willow.—In most cases trees of Russian golden, laurel-leaf, and diamond willow have been planted thickly as windbreaks and screens to hide buildings and feed lots. Plantings of willows were made in 1913, 1917, and 1918. Growth has varied with the location of the plantings. When the trees were planted along canals and ditch banks the growth has been rapid; they have reached a height of approximately 35 feet and have made a yearly growth of from 3 to 6 feet. Willows planted in less favorable locations have attained an average height of about 20 feet. All varieties have been comparatively hardy, and winter injury has usually been limited to tip killing. Losses from disease and insect pests have been small.

SHRUBS

Barberry, Japanese.—Plantings of Japanese barberry were made near the station buildings in 1913, and although not entirely winter hardy the bushes have survived and added some new growth each year. In 1926 the average height of the Japanese barberry was about 26 inches.

Caragana (Siberian pea tree).—Planted as a hedge or by itself the Siberian pea tree has shown itself to be winter hardy and generally well suited to local conditions. Although an occasional shrub has died from disease, the species as a whole has been little affected by insects or plant ailments.

Cranberry bush, American.—Numerous shrubs of the species formerly called "highbush cranberry" were planted on the station grounds in 1913 and in Project Park in 1917. The older shrubs were about 8 feet high in 1926 and have never shown any evidences of winter injury, disease, or insect attack. Where not crowded by surrounding trees or shrubbery the cranberry is a very attractive ornamental bush.

Currant.—Both the yellow-flowering and the Alpine varieties of currant seem to be fairly hardy and well adapted to planting in this locality. The yellow-flowering currant, planted in combination with other shrubbery around the station grounds in 1913, in some instances has reached a height of 6 feet. The growth is generally dense and tangled where the shrubs are not pruned, and nearly every year this variety has produced an abundance of fruit. The Alpine currant is a much smaller and finer-stemmed shrub than the former variety and apparently is not quite so hardy. Both varieties are attacked by mildew and leaf-spot diseases as well as by certain insect pests.

Dogwood, Siberian.—Siberian dogwood, planted in 1913 and 1917, has shown very little winter injury and has been apparently free from destructive agents. The height of the older shrubs was about 7 feet in 1926. The brilliant red bark of this species, together with its attractive foliage, makes the Siberian dogwood adaptable for either single or group plantings.

Elder, golden.—The golden elder is usually not entirely winter hardy in this region. It has not been uncommon to find as much as 80 per cent of the growth killed to the ground after a normal winter, and in severe winters the whole top has been killed. Growth from the crown has generally been rapid, however, as much as 10 feet being made in a single summer, so that at the end of the season the bushes are usually quite large. The yellow foliage of this plant makes it attractive for growing in combination with other shrubs.

Honeysuckle, Tartarian.—Although the Tartarian honeysuckle is occasionally injured by frost to the extent of tip killing, it is fairly hardy and well adapted to landscape plantings. Growth from the older wood is generally slow, but shoots from the crown of the old plant may reach a height of 3 to 4 feet in a single season. The Tartarian honeysuckle in the local plantings has shown little injury from insects or disease.

Lilac.—The common, Persian, and Japanese varieties of lilac have all grown well at the Huntley Field Station. Occasional severe winters or late frosts have

injured all of them to some extent, but for the most part they have been hardy and generally unaffected by insects or disease. Lilacs have done well in group plantings and when grown as specimen shrubs.

Mulberry, Russian.—The Russian mulberry usually kills back to the ground during the winter. New growth during the summer is rapid, and generally by mid-season the bushes are again 4 to 6 feet high. They are comparatively free from destructive agents.

Spirea.—Of spirea species, the Van Houtte (bridal wreath) has proved to be much more desirable than either the Anthony Waterer or the Sorbifolia in the plantings at Huntley. The bridal wreath is very attractive as a specimen ornamental and may be used effectively in combination with other shrubs in group plantings. The Anthony Waterer is a comparatively small bush, and although not as hardy or as showy as the Van Houtte, it may be considered a desirable plant for some locations. The Sorbifolia variety grows luxuriantly, but is undesirable because of the rapidity with which it spreads to surrounding territory by sending up shoots from rootstocks. All of the spireas have shown more or less winter injury, but this has generally been limited to tip killing.

Snowball.—Plantings of snowball made in 1913 and 1917 were still in a very thrifty condition in 1926. This species is generally winter hardy and except for aphid attacks has usually been free from insect pests and plant diseases. Snowball bushes set out in 1913 averaged about 7 feet in height in 1926. These have blossomed every season and have been an attractive addition to the plantings around the station buildings and in Project Park.

Syringa (mock orange).—Syringa planted on the station grounds in 1913 had reached a height of about 6 feet by 1926. This species has suffered little from winter injury and apparently has been free from disease and injurious insects.

EXPERIMENTS WITH DRY-LAND CROPS[3]

Investigations in dry-land agriculture have been in progress at the Huntley Field Station since 1912, and with the close of the 1926 crop season the results of 14 years of uninterrupted experimental work in dry farming are made available.

The principal lines of investigation followed during this period include a study of the common field crops grown in a large number of rotations and by various cultural methods, the use of certain grain and forage crops for hog pasture, crop-variety testing, and observations on the storage of rainfall in the soil and its use by crop plants.

These experiments are conducted under the supervision of the Office of Dry-Land Agriculture, United States Department of Agriculture, cooperating with other offices of the Department of Agriculture, and with the Montana Agricultural Experiment Station.

From the standpoint of dry farming, the crop seasons of 1925 and 1926 were similar in many respects. Both seasons began with a low moisture content of the soil at seeding time. Coupled with less than normal rainfall during the growing period, this resulted in generally low yields in 1925 and in many total failures in 1926. The experience of these two years demonstrates the fact that following a good crop year profitable yields may be expected from some methods of tillage during the first dry season, but during the second dry season the yields from all ordinary tillage methods generally will be low, and usually many crop failures may be looked for.

This report presents the information obtained from some of the major lines of investigation in dry-land agriculture at this station.

CROP RETURNS FROM ROTATION AND TILLAGE TESTS

A brief discussion of the crops and their response to various cultural treatments in 1925 and 1926, together with the average yields since 1912, will be presented under the principal crop headings.

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[3] Report prepared by A. E. Seamans.

WINTER WHEAT

In the rotation and tillage experiments with winter wheat the Kharkof variety has been used. This variety was planted for the 1925 and 1926 cropping work, but because of poor stands resulting from drought at the time of seeding for 1925 and injury to the 1926 crop from blowing out and soil drifting, the winter-wheat plots were reseeded to spring wheat. In 1925 Kubanka wheat was sown, and in 1926 the Marquis variety was used for this purpose. The yields presented for 1925 and 1926 are therefore those of spring wheat used in place of winter wheat. These two years are the only instances in the history of the station when it has been found necessary to reseed the winter-wheat plots to spring grain. In both seasons the highest yields were obtained from fallow land, and the lowest yields resulted from continuous cropping. The yield of wheat on fallow was 25.1 bushels in 1925 and only 7.1 bushels in 1926. Disked cornland, generally profitable for wheat production, made an average yield of 12.7 bushels per acre in 1925 and only 1.4 bushels in 1926. Plowing wheat stubble previous to seeding the land to wheat again proved to be inferior to disking the crop into the stubble without plowing, although the yields from both methods were low in 1925 and 1926.

TABLE 9.—*Yields of winter wheat under different methods of tillage in 1925 and 1926 and for the 14-year period, 1913–1926*

Seed-bed preparation	Preceding crop	Average number of plots	Average acre yields (bushels)		
			1925	1926	1913–1926
Fall plowed	Winter wheat	[1]4	4.6	0	11.9
Subsoiled	do	[2]1	5.8	0	12.7
Listed	do	[2]1	8.2	0	12.7
Disked grain stubble	do	[3]5	5.8	.8	11.0
Disked corn stubble	Corn	4	12.7	1.4	19.5
Fallow	Fallow	[4]10	25.1	7.1	27.9
Green manured	Winter rye	2	6.0	0	19.2
Do	Peas	2	21.0	.4	23.9
Total or average		29	[5]14.4	[5]2.8	[6]20.9

[1] Started in 1914. Two plots previous to 1917.
[2] Started in 1914.
[3] Started in 1917.
[4] Three plots in 1913 and 1914; 9 plots in 1915 and 1916; 10 plots after 1916.
[5] Average of 29 plots of spring wheat used in place of winter wheat.
[6] Because the number of plots was not the same each year, the figure given is the average of the average yields obtained each year and not the average of the average yields shown for each method.

Table 9 presents the average yields of wheat in the winter-wheat rotations and tillage methods for 1925 and 1926 and also the average yields for the 14-year period from 1913 to 1926, inclusive.

SPRING WHEAT

Kubanka spring wheat returned yields in 1925 somewhat lower than the average from most of the methods under trial. In 1926 this variety, because of the excessive drought, failed to produce a crop by any of the methods except summer fallow. With this treatment a yield of 7.3 bushels per acre was obtained. The average yield on summer-fallowed land was 25.3 bushels in 1925. This was the maximum-production method for the season and exceeded the

average for this method from 1913 to 1925, inclusive. The only other method that yielded more than its long-time average was green manuring with peas. The yield of 13.6 bushels of spring wheat on disked corn stubble ranked third in 1925, but was only 3.2 bushels per acre more than the average return of wheat on disked wheat stubble. The minimum yields were obtained from wheat on plowed stubble of wheat or other small grain. (Fig. 4.)

FIGURE 4.—Dry-land spring wheat grown on summer-fallowed land at the Huntley Field Station in 1925. Spring wheat grown by this method in 1925 returned an average acre yield of 25.3 bushels

The average yields of spring wheat under the various cultural methods in 1925 and 1926 and for the 14-year period from 1913 to 1926, inclusive, are shown in Table 10.

TABLE 10.—*Yields of spring wheat under different methods of tillage in 1925 and 1926 and for the 14-year period 1913–1926*

Seed-bed preparation	Preceding crop	Number of plots averaged	Average acre yields (bushels)		
			1925	1926	1913–1926
Fall plowed	Corn	1	9.8	0	14.0
Do	Oats	2	5.3	0	13.9
Do	Wheat	[1]3	3.6	0	11.2
Spring plowed	Corn	1	10.2	0	14.6
Do	Oats	1	5.5	0	11.4
Do	Wheat	1	7.0	0	10.4
Do	Flax	[2]1	8.5	0	12.9
Subsoiled	Wheat	1	5.8	0	10.7
Listed	do	1	9.7	0	13.0
Disked grain stubble	do	[3]4	10.4	0	10.7
Disked corn stubble	Corn	[4]12	13.6	0	15.6
Fallow	Fallow	[5]10	25.3	7.3	20.5
Green manured	Winter rye	1	10.0	0	17.1
Do	Peas	1	21.3	0	19.6
Do	Sweetclover	[2]1	6.8	0	15.1
Total or average		41	[6]14.0	[6]1.8	[7]15.9

[1] One plot previous to 1917.
[2] Begun in 1915.
[3] Begun in 1917.
[4] Eight plots 1913 and 1914, 12 plots since 1914.
[5] Three plots 1913 and 1914, nine plots 1915 and 1916, 10 plots since 1916.
[6] Average of 41 plots.
[7] Because the number of plots was not the same every year, the figure given is the average of the average yields obtained each year and not the average of the average yields shown for each method.

OATS

The Sixty Day variety of oats has been used in these experiments since they were begun. With the exception of oats on fallow, the yields of this crop in 1925 were less than the average. Land fallowed in 1924 returned an average of 52.8 bushels of oats per acre, which was the highest of any of the methods under comparison. Oats on peas plowed under for green manure and on disked cornland ranked second and third in yield for 1925, whereas the minimum yields were obtained in rotations where oats followed brome grass or alfalfa. In 1926 the excessive drought checked the growth of oats before they reached the heading stage, with the result that but little grain was matured and none of the rotations or tillage methods produced measurable yields.

Table 11 presents the oat yields obtained in 1925 and 1926 and also the averages for the 14-year period from 1913 to 1926, inclusive.

TABLE 11.—*Yields of oats under different methods of tillage in 1925 and 1926 and for the 14-year period 1913–1926*

Seed-bed preparation	Preceding crop	Number of plots averaged each year	Average acre yields (bushels)		
			1925	1926	1913–1926
Fall plowed	Wheat	[1]6	8.7	0	30.6
Do	Barley	1	8.8	0	30.6
Do	Oats	1	7.2	0	24.2
Spring plowed	Corn	2	13.4	0	32.1
Do	Wheat	[2]2	13.6	0	29.3
Do	Oats	1	11.9	0	24.9
Do	Flax	[3]1	18.8	0	26.1
Subsoiled	Oats	1	10.0	0	22.7
Listed	do	1	16.6	0	29.6
Disked corn stubble	Corn	[4]9	21.8	0	33.8
Fallow	Fallow	3	52.8	0	45.9
Green manured	Winter rye	2	16.0	0	37.7
Do	Peas	2	36.0	0	41.0
Do	Sweetclover	[3]1	16.3	0	34.6
Sod crops	Alfalfa	1	3.8	0	25.9
Do	Bromegrass	1	5.9	0	27.0
Total or average		35	[5]19.0	[5]0	[6]33.1

[1] 4 plots previous to 1915.
[2] 1 plot previous to 1915.
[3] Begun in 1915.
[4] 8 plots previous to 1915.
[5] Average of 35 plots.
[6] Because the number of plots was not the same every year, the figure given is the average of the yearly average yields and not the average of the average yields shown for each method.

BARLEY

Yields of Hannchen barley in these experiments were generally below normal in 1925 and were practically a failure in 1926. The maximum acre yield in 1925 was 33.8 bushels from summer fallow. Barley on disked flax stubble produced 18.3 bushels per acre in 1925 and held second place in point of production for the season. Barley on land green manured with peas and on disked corn stubble returned fair crops of grain in 1925, but somewhat less than the normal production for these methods.

The average yields for 1925 and 1926, together with the 14-year averages, are shown in Table 12.

TABLE 12.—*Yields of barley under different methods of tillage in 1925 and 1926 and for the 14-year period 1913–1926*

Seed-bed preparation	Preceding crop	Number of plots averaged	Average acre yields (bushels)		
			1925	1926	1913–1926
Fall plowed	Barley	[1] 1	2.3	0.6	10.0
Spring plowed	Oats	1	9.6	.6	15.9
Do	Barley	[1] 1	7.9	1.0	13.0
Disked flax stubble	Flax	[1] 1	18.3	0.	17.3
Disked corn stubble	Corn	4	12.9	.7	19.1
Fallow	Fallow	[1] 1	33.8	2.1	20.3
Green manured	Winter rye	1	8.8	.4	22.4
Do	Peas	1	15.8	.8	23.7
Total or average		11	[2] 13.4	[2] .7	[3] 19.4

[1] Begun in 1915.
[2] Average of 11 plots.
[3] Because the number of plots was not the same every year, the figure given is the average of the yearly average yields and not the average of the yields shown for each method.

FLAX

Summer-fallowed land produced an average acre yield of 8.9 bushels of flaxseed in 1925. This yield was about double the best return from any of the other methods under trial, but failed to equal the 13-year average for flax on fallow. Flax on spring-plowed land returned generally higher yields than flax on fall-plowed land. Disked cornland did not return in 1925 so large a yield of flax as did plowed cornland or plowed stubble of some of the small-grain crops, which behavior is in accord with the 1913–1925 average. In this respect the flax crop differed from most of the cereal crops. The flax crop in 1926 was practically a failure in all of the experiments, owing to drought. Measurable yields, however, were obtained from plots where the crop was grown on summer fallow, disked cornland, and spring-plowed corn stubble, the first method returning an average of 2.9 bushels per acre, which was the maximum yield for the season.

Table 13 presents the average yields obtained by the various methods in 1925 and 1926 and for the 14-year period, from 1913 to 1926, inclusive.

TABLE 13.—*Yields of flax under different methods of tillage in 1925 and 1926 and for the 14-year period 1913–1926*

Seed-bed preparation	Preceding crop	Number of plots averaged	Average acre yields (bushels)		
			1925	1926	1913–1926
Fall plowed	Corn	[1] 1	3.0	0	7.5
Do	Flax	[2] 3	2.1	0	6.1
Spring plowed	Oats	[1] 1	4.6	0	6.4
Do	Wheat	[1] 1	2.7	0	7.7
Do	Corn	[1] 2	3.7	1.5	7.8
Do	Flax	[2] 2	4.0	0	6.5
Subsoiled	do	1	3.0	0	5.0
Listed	do	1	4.1	0	5.5
Disked corn stubble	Corn	[1] 2	3.4	2.2	7.4
Fallow	Fallow	[2] 2	8.9	2.9	9.8
Total or average		16	[3] 4.0	[3] .8	[4] 7.2

[1] Begun in 1915.
[2] One plot previous to 1915.
[3] Average of 16 plots.
[4] Because the number of plots was not the same every year, the figure given is the average of the yearly averages and not the average of the average yields shown for each method.

CORN

Both 1925 and 1926 were poor seasons for corn, but fair returns of stover were obtained by most of the cultural methods under consideration. Drought and hot winds at the time the crop was tasseling dried up the silks before fertilization took place. The results were small grain yields in 1925 and no grain yields in 1926. The yield of 24.4 bushels of grain from corn on fallow in 1925 was outstandingly high for the season and lacked but a few bushels of reaching the average yield for the method. The next highest yield was 13.5 bushels from spring-listed cornland, which was about double the returns made by the remaining cultural methods. Stover yields in 1925 were practically up to normal under nearly all methods. The stover yields in 1926 were all less than normal but in some cases exceeded the yields of 1925.

The yields of grain and stover obtained in 1925 and 1926 are presented in Table 14 in comparison with the average returns for the 14-year period from 1913 to 1926, inclusive.

TABLE 14.—*Yields of corn under different methods of tillage in 1925 and 1926 and for the 14-year period 1913–1926*

Seed-bed preparation	Preceding crop	Number of plots averaged	Average acre yields					
			1925		1926		1913–1926	
			Grain	Stover	Grain	Stover	Grain	Stover
			Bushels	*Pounds*	*Bushels*	*Pounds*	*Bushels*	*Pounds*
Fall plowed	Oats	4	2.7	900	0	538	16.6	1,614
Do	Spring wheat	2	2.9	1,200	0	435	17.3	1,576
Do	Flax	[1]1	2.4	800	0	400	15.8	2,224
Do	Winter wheat	[1]1	2.0	1,800	0	1,320	24.3	2,651
Do	Corn	1	6.4	1,300	0	930	15.7	1,695
Spring plowed	Spring wheat	[2]5	3.3	1,520	0	980	18.0	1,702
Do	Oats	[3]13	6.3	1,746	0	1,145	18.4	1,858
Do	Winter wheat	[4]6	8.7	1,750	0	1,368	17.1	1,696
Do	Barley	3	5.9	1,133	0	1,150	18.3	1,614
Do	Flax	[3]3	3.5	1,567	0	1,280	16.9	2,047
Do	Corn	1	4.0	900	0	920	16.6	1,512
Subsoiled	do	1	5.1	1,200	0	850	15.9	1,895
Listed	do	1	13.5	800	0	1,400	23.8	1,476
Fallow	Fallow	1	24.4	2,200	0	1,870	28.3	2,454
Total or average		43	[5]5.9	[5]1,486	[5]0	[5]1,070	[6]18.4	[6]1,796

[1] Begun in 1915.
[2] 4 plots previous to 1915.
[3] 9 plots previous to 1915.
[4] Begun in 1914.
[5] Average of 43 plots.
[6] Because the number of plots was not the same every year, the figure given is the average of the yearly average yields and not the average of the average yields shown for each method.

EXPERIMENTS IN PASTURING DRY-LAND CROPS WITH HOGS

In the experiments in pasturing dry-land crops with hogs, both annual and perennial crops were used for pasture.

ANNUAL-CROP PASTURES

As originally outlined in 1915, the annual crops to be used for this purpose were winter rye, peas, beardless barley, and corn, arranged in a rotation and pastured in the order named. The purpose of these investigations was not only to determine the suitability of these

crops for grazing livestock but also to obtain agronomic information as to the dates at which these crops are available for pasturing, the length of the grazing period for each crop, the possibility of fitting together a series of crops for the production of continuous palatable forage throughout the season, and the effects on succeeding crops of the manure resulting from pasturing.

A similar rotation in which the crops are not pastured but are allowed to mature and are harvested by machinery has been used as a means of measuring the agronomic results of pasturing and the economic merits of harvesting the crops with hogs as compared with harvesting the crops with machinery. Previous to 1924 fall pigs were used for harvesting all of the crops except corn, which was pastured by spring pigs. Since 1924 spring pigs have been started on the plot of winter rye, and an attempt has been made to have green forage of some kind available to them until they can be turned into the plot of mature corn for finishing.

As beardless barley failed to produce satisfactory gains when pastured, it has not been grazed since 1923, but the barley in the pastured rotation has been harvested by machinery and the yields from it compared with the yields of barley in the rotation that has never been pastured. This forms an additional means of measuring the effects of pasturing on the land.

In place of the barley pasture the hogs were given access to a plot of Sudan grass and soy beans, which crops preliminary tests had shown generally to remain green and palatable during the dry period beginning late in July and extending throughout August and into early September. After consuming these crops the hogs were turned into the plot of ripening corn.

In 1925 and 1926 the winter rye in both the pastured and the harvested rotations was winterkilled, and it was necessary to reseed the land to spring grains. A combination of spring wheat and oats, one-half acre of each, was used for this purpose in 1925, but in 1926 oats alone were planted.

The pasture season on these crops opened June 5 and June 9 in 1925 and 1926, respectively, 15 spring pigs being placed on the reseeded plots on those dates. In addition to the pasturage the pigs were allowed a supplementary ration of shelled corn in a self-feeder.

On the date the pigs were placed in the pastures a check lot of similar pigs was started in a dry pen, without pasture, on a full-feed ration of corn and skim milk. The purpose of the check lot was to determine the value of the pastures through the medium of the grain consumed by each lot.

The pasture season on wheat and oats in 1925 lasted 42 days, as compared with a 28-day period in 1926, when severe drought prevented normal crop growth. Although fair daily gains were made in both seasons, the increase in weight of the pigs in 1925 was produced at a loss, whereas in 1926 the gains on pasture were made at a profit as compared with the performance of the pigs in the check lot.

The pigs were moved from the first pasture to the plot of peas, which, in both 1925 and 1926, carried the animals for 14 days. The daily gains made on peas were greater than on the grain pastures, but they were produced at a loss in 1925 and at a slight profit in 1926, in comparison with the gains made by the dry-lot pigs.

From the plot of peas the hogs were moved to plots of Sudan grass and soy beans. In 1925 an acre of this combination furnished grazing for a period of 28 days, and in 1926 one-half acre furnished grazing for 14 days. In both years the maximum daily gains of the season were made on the Sudan grass-soybean pasture, and the gains on these pastures were less costly in grain consumed than those made by the check lots. Following the Sudan grass-soybean pasture in 1926, the hogs were placed on a half-acre plot of sorgo and soy beans, which lasted for another 14-day period. As compared with the growth of the hogs in the dry lot, the grain replacement value of the sorgo-soy bean pasture was 490 pounds per acre, the highest of the season.

Table 15.—*Results obtained from pasturing various dry-land crops with spring pigs, in 1925 and 1926*

Items of comparison	Spring wheat and oats, 1925	Oats, 1926	Peas		Sudan grass and soy beans	
			1925	1926	1925	1926
Area of plot—acres	1	1	1	1	1	0.5
Test began	June 5	June 9	July 17	July 7	July 31	July 21
Test closed	July 17	July 7	July 31	July 21	Aug. 28	Aug. 4
Length of test—days	42	28	14	14	28	14
Number of pigs	15	15	15	15	15	15
Average weight of pigs:						
Initial—pounds	46.0	36.7	77.9	55.3	89.5	65.6
Final—do	77.9	55.3	89.5	65.6	112.7	77.8
Gain—do	31.9	18.6	11.6	10.3	23.2	12.2
Daily gain—do	.76	.66	.83	.74	.83	.87
Total gain—do	479	278	174	155	348	183
Total feed consumed [1]—do	2,007	857	798	523	1,242	500
Feed per 100 pounds of gain:						
Pasture lot—do	419	308	459	337	357	273
Check lot [2]—do	350	322	437	384	476	380
Corn replaced per acre of pasture—do	−331	39	−38	73	414	392
Acre yields of check plots—bushels	[3]	2.0	.5	0	[4]	[5]

Items of comparison	Sorgo and soy beans, 1926	Corn		Total or average	
		1925	1926	1925	1926
Area of plot—acres	0.5	1	1	4	4
Date test began	Aug. 4	Aug. 28	Aug. 18	June 5	June 9
Date test closed	Aug. 18	Sept. 7	Sept. 1	Sept. 7	Sept. 1
Length of test—days	14	10	14	94	84
Number of pigs	15	15	15	15	15
Average weight of pigs:					
Initial—pounds	77.8	112.7	88.5	46.0	36.7
Final—do	88.5	119.7	100.3	119.7	100.3
Gain—do	10.7	7.0	11.8	73.7	63.6
Daily gain—do	.76	.69	.85	.78	.76
Total gain—do	160	104	178	1,105	954
Total feed consumed [1]—do	516	----------	716	4,047	3,112
Feed per 100 pounds of grain:					
Pasture lot—do	323	----------	402	366	326
Check lot [2]—do	476	329	380	397	375
Corn replaced per acre of pasture—do	490	342	−39	97	191
Acre yields of check plots—bushels	----------	6.3	[6]	----------	----------

[1] Self-fed corn.
[2] Check lot fed in a dry pen without pasture consisted of 8 pigs in both 1925 and 1926. Corn self-fed; skim milk hand fed; the total calculated as corn on the basis of 4 pounds of milk equaling 1 pound of corn.
[3] Oats, 14.4 bushels; wheat, 4.4 bushels.
[4] Sudan grass, 1,260 pounds; soy beans, 338 pounds.
[5] Sudan grass, 1,040 pounds; soy beans, 200 pounds.
[6] Fodder in 1926, 710 pounds.

The hogs were placed on the plot of corn on August 28 in 1925 and on August 18 in 1926. In 1925 a small crop of ear corn was matured, which furnished grazing for 10 days, and no grain supplement was fed. Although the average daily gains made on this crop were comparatively low, they were more profitable than those made by the check-lot pigs. No ear corn was produced in 1926 on the plot to be pastured, but when the pigs were turned into the field much of the fodder was still green and succulent. This, with the addition of a supplement of shelled corn, produced fair daily gains, but the consumption of corn for each 100 pounds of gain was greater than in the check lot.

The data obtained in 1925 and 1926 from pasturing spring pigs on the various annual crops are assembled in Table 15. The quantity of grain required to produce 100 pounds of gain on pasture and in the check lot, together with the grain-replacement value of the pastures and the yields of harvested plots, are also shown.

FIGURE 5.—Hogs on dry-land alfalfa pasture in 1925. These hogs on one-half acre of alfalfa in 1925 made an average daily gain of 1½ pounds each during a pasture period of 70 days. In addition to the pasture the hogs received a daily ration of shelled corn equal to 3 per cent of their live weight. They returned 1 pound of gain for each 3.66 pounds of corn fed to them.

PERENNIAL CROP PASTURES

Beginning with the season of 1917, alfalfa and brome grass have been pastured by fall pigs in these experiments. Each of these crops is represented by two methods of seeding, in rows 2 feet apart and close drilled or broadcast. All plots were pastured simultaneously. Check plots, from which these crops are harvested as hay, are maintained for comparison with the pastures.

In 1925 and 1926 half-acre plots were used for pasturing. The pigs were allowed a supplementary ration of shelled corn equal to 3 per cent of the live weight of the animals. Three fall pigs were used to pasture each half-acre plot in each of the two years. (Fig. 5.)

The pasture season on alfalfa and brome grass began May 8 in 1925 and May 13 in 1926. In 1925 the pasture season extended over a period of 70 days for each crop, but in 1926 the drought limited the pasture period to 41 days. The average daily gain in both seasons was more than a pound a day on all plots. The gains made on alfalfa were consistently greater than those made on brome grass, and the gains on the row plots of each crop were greater than those on the broadcast plots.

A check lot of eight fall pigs was maintained in a dry pen on a full-feed ration of corn and skim milk in 1925, but because of the shortage of hogs no such lot was used in 1926. If the grain consumed to make 100 pounds of gain on pasture is compared with a similar gain in the check lot without pasture, the former system of growing the hogs was more profitable in 1925 for all plots, except the broadcast brome-grass pasture, which resulted in a loss.

Table 16 presents the data obtained from the experiments in pasturing alfalfa and brome grass with fall pigs in 1925 and 1926, together with the comparative gains of the pasture and the check lots and the hay yields of the check plots upon which the crops were not pastured.

TABLE 16.—*Results obtained from pasturing alfalfa and brome grass with fall pigs in 1925 and 1926*

Items of comparison	Alfalfa				Brome grass			
	Rows		Broadcast		Rows		Broadcast	
	1925	1926	1925	1926	1925	1926	1925	1926
Area of plot—acres	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Test began	May 8	May 13	May 8	May 13	May 8	May 13	May 8	May 13
Test closed	July 17	June 23	July 17	June 23	July 17	June 23	July 17	June 23
Length of test—days	70	41	70	41	70	41	70	41
Number of pigs	3	3	3	3	3	3	3	3
Average weight of pigs:								
Initial—pounds	130.3	145.7	127.0	146.3	125.3	157.0	126.7	153.3
Final—do	235.3	209.7	218.0	206.3	210.0	205.7	201.3	205.0
Gain—do	105.0	64.0	92.0	60.0	84.7	48.7	74.6	51.7
Daily gain—do	1.50	1.56	1.31	1.46	1.21	1.19	1.07	1.26
Total gain—do	315	192	276	180	254	146	224	155
Total feed consumed [1]—do	1,154	631	1,120	631	1,092	630	1,064	630
Feed per 100 pounds gain:								
Pasture lot—pounds	366	329	406	351	430	432	475	406
Check lot [2]—do	441	----------	441	----------	441	----------	441	----------
Corn replaced per acre of pasture—pounds	473	----------	193	----------	56	----------	152	----------
Acre yield of hay from check plots—pounds	640	520	200	0	320	0	160	0

[1] 3 per cent corn.

[2] Check lot of 8 fall pigs fed in a dry pen without pasture in 1925. No check lot used in 1926. Corn self-fed; skim milk hand fed; the total calculated as corn on the basis of 4 pounds of milk equaling 1 pound of corn.

CROP-UTILIZATION EXPERIMENTS[4]

Hogs are used each year to harvest the corn and third-year alfalfa in rotation 67, field K, and in rotation 69, field L–IV. The purpose of this work is to determine the advisability of disposing of irrigated crops in this manner and the effect of such a practice on the subsequent yields of crops.

[4] Report prepared by David A. Savage.

PASTURING ALFALFA WITH HOGS

The alfalfa-pasturing experiments were begun in 1914 in rotation 67 and in 1917 in rotation 69. The former rotation comprises three years of alfalfa, the third year hogged, followed by corn (hogged), flax, and beets; while the latter is represented by three years of alfalfa, the third year hogged, two years of corn (hogged), and oats. Each rotation occupies 6 quarter-acre plots.

Spring pigs are generally too small to be used on the pasture when growth starts in the spring, and fall pigs, carried over the winter on a maintenance ration and used on spring pasture, are usually ready for market by the 1st of July. The pasturing season is therefore divided into the spring period, extending from May to July, and the summer period from July to October. The fall pigs ordinarily weigh 90 to 125 pounds when placed on pasture in the spring, while the spring pigs usually weigh about 50 pounds when placed on summer pasture in July. Palatable grazing is supplied at all times, and the pastured alfalfa is allowed to recuperate by dividing each plot into two equal areas and moving the hogs from one to the other when irrigation is required. As a supplement to the pasture, the hogs are fed a daily corn ration equal to 2 per cent of their live weight. The hogs are weighed every two weeks, and the grain ration is calculated from these weighings. Five fall pigs and eight spring pigs are generally used on each plot.

The results of pasturing third-year alfalfa for the years 1914 to 1926, inclusive, are given in detail in Table 17.

TABLE 17.—*Results of pasturing third-year alfalfa in irrigated rotations with spring and fall pigs receiving a 2 per cent corn ration on pasture for the 13-year period 1914–1926*

Field and year	Number of pigs		Total days	Total weight (pounds)		Gain in weight (pounds)			Corn ration per 100 pounds of gain (pounds)	
						Total	Average daily			
	Fall	Spring		Initial	Final		Fall pigs	Spring pigs	Fall pigs	Spring pigs
1914	4	9	138	818	1,393	575	0.90	0.42	323	223
K 1915	5	8	150	1,091	1,710	619	.86	.54	414	212
1916	5	8	145	880	1,638	758	1.07	.63	260	197
K 1917	5	8	152	822	1,442	620	1.16	.33	281	293
L 1917	5	9	150	820	1,365	545	1.01	.43	281	258
K 1918	5	8	148	804	1,366	562	.88	.44	309	236
L 1918	5	8	148	800	1,390	590	.85	.42	323	248
K 1919	5	8	159	930	1,549	619	1.01	.39	306	292
L 1919	5	8	161	925	1,449	524	.89	.31	344	343
K 1920	5	8	134	703	1,188	485	.78	.43	237	273
L 1920	5	8	134	693	1,138	445	.78	.40	224	321
K 1921	4	8	124	965	1,466	501	.93	.52	343	270
L 1921	4	8	125	967	1,470	503	.87	.55	366	221
K 1922	5	8	131	913	1,504	591	.86	.59	351	206
L 1922	5	8	131	923	1,522	599	.91	.57	335	215
K 1923	5	8	119	1,070	1,698	628	1.14	.59	281	256
L 1923	5	8	128	1,040	1,635	595	1.15	.46	286	327
K 1924	5	(1)	70	590	885	295	.84	(1)	355	(1)
L 1924	5	(1)	70	584	865	281	.81	(1)	364	(1)
K 1925	5	8	142	1,057	1,729	672	.90	.62	341	264
L 1925	5	8	142	1,056	1,684	628	.85	.57	357	255
K 1926	5	8	132	1,048	1,711	663	1.04	.61	321	198
L 1926	5	8	132	1,048	1,707	659	1.09	.57	307	211
Average			133	893	1,457	564	.94	.49	318	253

[1] An outbreak of hog cholera interrupted the experiments in 1924.

According to the results for the entire period in both fields, fall pigs made an average daily gain of 0.94 pound and consumed 318 pounds of corn for each 100 pounds of gain in weight. The average daily gain of spring pigs was 0.49 pound, and the amount of corn in addition to pasture required to produce 100 pounds of gain was 253 pounds.

An interesting fact shown in Table 17 is the high carrying capacity of alfalfa pasture for hogs. An average of 20 fall pigs per acre was used on spring pasture, and 32 spring pigs per acre were carried on summer pasture. As shown in a later table, fall pigs generally weighed 120 pounds and spring pigs about 50 pounds when placed on pasture.

With the exception of the summer period in 1924 and the spring period in 1926, check lots of pigs were fed in the dry lot for comparison with those on pasture during the years 1922 to 1926, inclusive. Three of the dry-lot checks were self-fed corn and tankage; one, corn and middlings; three, self-fed corn and hand-fed skim milk; and one was self-fed corn and tankage and hand-fed skim milk.

In Table 18 are given the summarized results of this comparison.

TABLE 18.—*Average results obtained by pasturing pigs on alfalfa, with a 2 per cent corn ration, compared with check lots of pigs self-fed a balanced ration in a dry lot*[1] *in stated years*

Items of comparison	Fall pigs used for spring-pasture period (1922–1925)			Spring pigs used for summer-pasture period (1922, 1923, 1925, and 1926)		
	Rotation No.		Dry lot check	Rotation No.		Dry lot check
	67	69		67	69	
Average number of days	69	69	51	67	69	72
Average number of pigs	5	5	9	8	8	9
Area of plot—acres	0.25	0.25	[2]	0.25	0.25	[2]
Grain ration	[3]	[3]	[4]	[3]	[3]	[4]
Total weight per lot:						
Initial—pounds	605	607	1,089	383	375	424
Final—do	925	922	1,978	703	675	1,177
Average weight per pig:						
Initial—do	121.0	121.3	114.7	48.0	46.9	47.9
Final—do	184.9	184.5	208.1	87.9	84.4	136.0
Average gain:						
Per pig—do	64.0	63.2	93.4	39.9	37.6	88.1
Daily—do	0.94	0.93	1.81	0.60	0.54	1.18
Feed per 100 pounds of gain—do	332	335	431	233	252	393
Feed replaced per acre of pasture—do	1,312	1,256	----------	2,017	1,696	----------

[1] 3 of the check lots of pigs were self-fed corn and tankage; 1, corn and middlings; 3, self-fed corn and hand-fed skim milk; and 1 was self-fed corn and tankage and hand-fed skim milk.
[2] Dry lot.
[3] 2 per cent corn.
[4] Self-fed.

The grain required to produce 100 pounds of gain in the dry lot was approximately 100 pounds more than on pasture. The average quantity of grain supplement consumed on spring pasture for each 100 pounds of gain was 332 pounds in rotation 67 and 335 pounds in rotation 69, as compared with 431 pounds in the dry lot. Even greater differences in this respect were noted during the summer period. The quantities of grain required for each 100 pounds of gain in rotations 67 and 69 and in the dry-lot check were 233, 252,

and 393 pounds, respectively. Calculated to an acre basis, spring-pastured alfalfa in rotations 67 and 69 was equivalent to 1,312 and 1,256 pounds of grain, respectively, while summer-pastured alfalfa in the same rotations replaced 2,017 and 1,696 pounds of grain. Although the total gain and rate of daily gain were higher on spring pasture, more grain was required to produce 100 pounds of gain.

HOGGING OFF CORN

As soon as the summer-pasture period of alfalfa in rotation 67 is completed, the hogs are moved to a quarter acre of corn in the same rotation. An average of 24 days is required to consume the corn. The results of this test, calculated to an acre basis, are presented in detail for the period 1912 to 1926, inclusive, in Table 19. The average gain produced was at the rate of 710 pounds per acre. From the estimated yields of corn it was shown that 471 pounds of grain was required for each 100 pounds of gain in weight.

TABLE 19.—*Results of hogging off irrigated corn in rotation 67 for the 15-year period 1912–1926*

Year	Number of pigs	Number of days	Total weight of pigs (pounds)			Grain fed per 100 pounds of gain (pounds)[1]	Yield (bushels)[1]
			Initial	Final	Gain		
1912	20	16	2,900	3,288	388	530	56.4
1913	16	23	1,312	2,080	768	440	60.0
1914	16	22	1,380	2,276	896	320	50.4
1915	16	25	1,376	2,240	864	450	52.4
1916	16	20	1,516	2,188	672	500	60.0
1917	16	24	1,200	1,828	628	380	43.2
1918	16	27	1,428	2,152	724	510	65.0
1919	16	27	1,636	2,112	476	410	55.0
1920	32	22	2,652	3,444	792	469	66.4
1921	32	18	2,916	3,572	656	609	72.3
1922	32	28	2,452	3,384	932	492	82.0
1923	24	30	2,632	3,560	928	362	60.0
1924	24	21	3,552	4,276	724	520	67.3
1925	24	23	2,916	3,520	604	464	50.0
1926	24	34	2,548	3,136	588	604	63.0
Average	22	24	2,160	2,870	710	471	60.2

[1] Estimated.

HOGGING OFF CORN AND RAPE

Two ¼-acre plots of corn in rotation 69 were interplanted with Dwarf Essex rape at the time of the last cultivation. The latter crop makes considerable growth by the time the corn is mature and both crops are hogged off. Eight hogs are generally used on the half-acre area. The results covering the 11-year period from 1916 to 1926, inclusive, as calculated to an acre basis, are shown in Table 20.

HOGGING CORN ALONE COMPARED WITH HOGGING CORN AND RAPE

The summarized results of hogging corn alone, as compared with hogging corn and rape, are calculated to an acre basis and presented in Table 21. The advantage in favor of corn and rape is clearly apparent. The weight of pork produced where rape was grown with the corn was 83 pounds per acre more than was realized from corn alone. The average daily gain was 1.35 pounds per hog per day on

corn alone and 1.37 pounds on corn and rape. On the basis of an estimate of the yields, 471 pounds of corn was required to make 100 pounds of gain on corn pastured alone, while 405 pounds was consumed for each 100 pounds of gain on corn and rape.

TABLE 20.—*Results of hogging off corn and rape in rotation 69 for the 11-year period 1916–1926*

Year	Number of pigs	Number of days	Total weight of pigs (pounds)			Grain fed per 100 pounds of gain, (pounds)[1]	Yield (bushels)[1]
			Initial	Final	Gain		
1916	8	38	660	1,246	586	485	50.8
1917	16	22	1,168	1,700	532	433	41.4
1918	16	36	1,156	1,964	808	380	55.0
1919	16	29	1,116	1,930	814	241	60.0
1920	16	39	1,198	2,038	840	392	57.7
1921	16	43	1,474	2,228	754	479	64.5
1922	16	40	1,226	2,068	842	511	76.3
1923	20	30	2,196	3,186	990	339	60.0
1924	20	32	1,642	2,420	778	444	61.7
1925	20	29	2,250	3,136	886	422	65.0
1926	20	34	2,100	2,998	898	332	53.2
Average	17	34	1,471	2,264	793	405	58.7

[1] Estimated.

In an additional test of hogging off corn conducted in 1925 a 3-acre field of Payne White corn was used, and the estimated acre yield was 40 bushels.

TABLE 21.—*Results of hogging off corn alone and corn and rape in stated years*

Items of comparison	Rotation 67, corn alone, 1912–1926	Rotation 69, corn and rape, 1916–1926
Number of years	15	11
Average number of pigs per acre	22	17
Average number of days on test	24	34
Average total weight per lot:		
Initial—pounds	2,160	1,471
Final—do	2,870	2,264
Total gain per acre of corn—do	710	793
Average weight per pig:		
Initial—pounds	98.2	86.5
Final—do	130.5	133.2
Average gain—do	32.3	46.7
Daily gain—do	1.35	1.37
Estimated yield of corn per acre—bushels	60.2	58.7
Estimated grain consumed per 100 pounds of gain—pounds	474	415

The test was begun November 4, when 24 shotes with an average initial weight of 182.4 pounds were placed in the field. A period of 46 days was required for the hogs to clean up all of the corn. The hogs made an average gain of 60 pounds each while on the corn. The grain (estimated) required per 100 pounds of gain was 465 pounds.

The results of this test are given in Table 22.

TABLE 22.—*Results of hogging off corn in 1925*

[Test begun Nov. 4 and closed Dec. 20]

Area of field—acres	3	Average weight:	
Length of test—days	46	Initial—pounds	182.4
Number of hogs	24	Final—do	242.5
Total weight:		Average gain per hog—do	60.1
Initial—pounds	4,377	Estimated acre yield of corn—bushels	40.0
Final—do	5,819	Estimated grain per 100 pounds of gain—pounds	465

EXPERIMENTS WITH DAIRY CATTLE

In cooperation with the Huntley Station the Bureau of Dairy Industry maintains a herd of purebred Holstein cattle. Experiments are being conducted in breeding and feeding dairy cows and in grazing irrigated pastures.

The experiments in breeding are a part of the breeding studies on dairy cattle conducted by the Bureau of Dairy Industry. In these experiments, sires that have shown by the producing ability of their daughters that they are prepotent in transmitting the capacity for uniformly high milk and butterfat production will be used for generation after generation as a method of improving dairy cattle.

The feeding tests have compared the relative economy of production for cows fed roughage alone with that of cows fed a limited and a full feed of grain in addition to roughage. Experiments in grazing irrigated pastures have included carrying-capacity tests of various pasture-grass mixtures and of pastures top-dressed with manure as compared with pastures receiving no manure.

The results of the experiments with dairy cattle are reported in a separate publication.[5]

[5] MOSELEY, T. W., STUART, D., and GRAVES, R. R. DAIRY WORK AT THE HUNTLEY FIELD STATION, HUNTLEY, MONT., 1918–1927. U. S. Dept. Agr. Tech. Bul. 116. (In press.)

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